FOREST PEST MANAGEMENT
Pacific Southwest Region

83-07

Report No. 83-07
LAT 39.06875 LON -120.07975
3430 Evaluation
May 16, 1983

BIOLOGICAL EVALUATION OF FIR CRAGS HOME TRACT, MEEKS BAY RECREATION AREA, AND NEVADA BEACH CAMPGROUND, LAKE TAHOE BASIN MANAGEMENT UNIT

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ABSTRACT

Three recreation areas in the LTBMU were evaluated for pests with the objective of developing alternative vegetation management strategies. The three areas are the Meeks Bay recreation area, Nevada Beach campground, and the Fir Crags summer home tract. The principal concern at Fir Crags is the potential for failure of hazardous trees, especially those that have root and trunk rot. Heavy stocking is also a potential problem. The Nevada Beach campground is heavily stocked in many areas and has varying intensities of western dwarf mistletoe infections. Thinning and dwarf mistletoe control options are provided that are suitable for the different areas of the campground. The Meeks Bay recreation area has two separate, primary problems: western dwarf mistletoe and overstocking in the concessionaire's portion, and flooding and mountain pine beetle in the Forest Service campground. Pest and vegetation management alternatives are identified which could alleviate these situations.

INTRODUCTION

In response to a request from the Forest Supervisor, Lake Tahoe Basin Management Unit (LTBMU), we conducted a biological evaluation of several recreation sites during the week of June 28-July 2, 1982. The sites included the Kiva-Taylor Creek complex, the Meeks Bay recreation area (concessionaire resort and campground), the Fir Crags summer home tract, and the Nevada Beach recreation area. The evaluation of the Kiva-Taylor Creek area was reported previously (reference 3430 Memorandum to Forest Supervisor, LTBMU, January 14, 1983). This report documents the evaluation of the other three areas.

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We discussed the priorities and objectives of our evaluation with Bob McDowell (Resources Staff Officer) and Jim Schellenger (Small Sales Officer) prior to and during our field visit. From these discussions, we established that the purpose of the evaluation was to identify existing and potential pest situations and to provide information on the expected future conditions of each site. Knowing this, we developed management alternatives for consideration by the LTBMU in the development of silvicultural prescriptions and vegetation management plans.

Because of the similarity of pest situations to those previously observed and reported on in the LTBMU, we reference the above-mentioned 1983 report and a 1980 report (3430 Memorandum to Forest Supervisor, LTBMU, October 29, 1980) where appropriate for general management and biological information.

FIR CRAGS

Fir Crags is a 16-unit summer home tract along the Truckee River. The overstory is primarily old-growth red fir, with lesser amounts of white fir, Jeffrey pine, and lodgepole pine. White fir is the principal woody species in the understory and is especially dense in openings. The leased land with summer homes is about 6 acres. The primary concern is with hazardous tree situations because of the age and species of trees involved.

We observed several pests and defects in the old-growth firs that could result in tree weakening and failure. One to several conks of the Indian paint fungus, Echinodontium tinctorium, were seen on the boles of individual old-growth firs. The western side of the tract borders a steep slope and many of the old-growth firs on the lower part of this slope have large, old, open basal scars on the uphill side indicative of past fire injury. Most of the unhealed wounds have exposed wood that is decayed and infested with wood-boring insects. The trees generally tend to be leaning into the wound because of the slope. Annosus root disease centers, caused by Fomes annosus, were identified in 6 locations in Fir Crags. All of these centers involve only true firs. Their locations are noted on maps sent under separate cover. True fir dwarf mistletoe, often present in stands of this type, was not seen in the stand at Fir Crags. Signs of the fir engraver, Scolytus ventralis, also frequently active in older fir stands, were observed very infrequently.

MANAGEMENT ALTERNATIVES

1. Continue Current Management Direction. The area will be managed with the objective of detecting and treating hazardous tree situations. No other vegetation management practices will occur. Annosus root disease centers will continue to expand as long as there are root contacts with surrounding live firs. Trees with substantial root and butt rot will have a higher probability of failure, especially during severe winter storms. Centers additional to those identified may be present

because of the mode of action of this pathogen in true firs and the difficulty of detecting it in live trees. When hazardous trees are removed, new annosus centers may be created by spore infection of the fresh stumps.

Although currently at low levels, the fir engraver may cause an increase in top-kills and patch-kills along the bole and may contribute to an increase in mortality, particularly in trees weakened by root disease or other factors.

The program of evaluating trees for hazard will concentrate on those trees, especially firs, that could strike permanent structures. The likelihood of failure occurring is highest during the winter, when the only targets will be the structures. The probability of failure for most trees will depend primarily on three factors: the extent of root and butt rot, the extent of trunk rot, and the occurrence and severity of unusual weather conditions, such as heavy snow and strong winds from directions not normally experienced. Two indicators of root and butt rot are the proximity of the tree to annosus root disease centers and the presence, size, and age of basal wounds. When evaluating the effect of root and butt rot on tree integrity, the inspectors need to consider compounding factors, such as basal wounds, lean, tree vigor, the amount of sound sapwood, and soil depth, and how they might interact with the decayed roots and butt.

The heartrot of true firs caused by E. tinctorium can be evaluated by the number, size, and distribution of conks on a tree and by the rate of radial growth. Conk size is reflective of conk age and, therefore, the advanced stage of decay. When conks are greater than 6 inches across, the decay associated with them is advanced and stringy and may extend several feet on each side of the conk. When several conks are widely separated on a tree, the decay is extensive throughout the trunk. When interpreting heartrot for failure potential, the investigator needs to consider compounding factors, such as trunk wounds, sapwood decays, thickness of sound sapwood, and leans. If the rate of radial growth is high, there may be sufficient sound wood being added to the cylinder to accommodate any loss to heartrot.

The occurrence of unusual weather conditions can also influence the probability of failure. Strong winds from directions differing from the norm can place new stresses on trees. The effect of these types of winds can be compounded by other factors such as saturated soils or heavy snow and ice loads in the crowns. Human activities can also influence these unusual conditions. For example, opening the canopy through tree removal can alter wind patterns, which may have adverse consequences on residual trees.

2. Thinning. Removal of part of the overstory would have several effects. Proper selection of trees would reduce the number of defective trees that could fail and result in damage to structures. To the extent that thinning results in a more vigorous stand, potential damage by the fir engraver should be reduced or prevented. Understory trees would be released and increase in height growth rate to become eventual replacement trees. Dense thickets of understory white fir would also need to

be thinned to gain the most benefit from the release treatment. Thinning could affect a change in the understory composition so that the future stand had more pine and less fir, thereby increasing variety and reducing hazard. The number of understory trees that develop decay from E. tinctorium in the future could be reduced, because of the lessened opportunity for infection. Removal of overstory trees could kill some of the understory; this could be beneficial if it acts as a thinning, but would be detrimental if replacement trees are wounded. Overstory removal could increase the hazard potential in two ways: undetected butt or heartrot could cause trees to fall in a direction different from that predetermined by the faller and thereby damage structures, and the opening of the canopy could result in an increased chance of windthrow if the roots of the residual trees are not strong enough to withstand different wind pressures.

3. Annosus Root Disease Management. The probability of the formation of new centers can be reduced by the application of borax (sodium tetraborate decahydrate, EPA Reg. No. 1624-94) to all freshly cut conifer stumps in the home tract area (see FSM 2305, 2331.33 R-5 Supplement No. 90). Vegetation in and around centers should be converted to pine, preferably Jeffrey pine. These species appear to be resistant or tolerant of infection by F. annosus that occurs in firs. A light thinning of firs immediately surrounding active centers might increase their tolerance to infection through increasing the rate of root regeneration and replacement.

4. Vegetation Management. The decision on the intensity and need for vegetation management depends partly on the future of the summer home tract and the time remaining on the leases. If the tract is to be closed within two decades, then more damage and disruption may occur by attempting to make major changes in the vegetation at the present time. It may be simpler and more effective to delay any actions, except the removal of hazardous trees, until after the closing of the tract. At that time significant changes, including substantial harvesting and regenerating, could take place.

If the summer home tract is to be maintained for many decades, then some vegetation management should be planned that would retain an adequate and safe vegetative cover, but not be disruptive or damaging to the site or occupants. A selection system would appear best suited to these purposes, although the ultimate result of an all-aged stand would be difficult to accomplish because of the high proportion of old-growth dominants in the present stand. The growth of the understory could be encouraged, however, by removal of some of the overstory. Small openings might be developed that could be planted to pines or suitable hardwoods to provide greater diversity. A smaller proportion of old-growth firs could be retained for their aesthetic, sheltering, and wildlife benefits. The selection and removal of individual trees would need to be done over an extended period of time with some attempts at regenerating certain areas with selected species.

MEEKS BAY (CONCESSIONAIRE)

The Meeks Bay Resort is on the north side of Meeks Creek and is operated by a private concessionaire. This 25-acre site includes a main lodge and numerous cabins, as well as boat docks on the lake. The vegetation is primarily Jeffrey pine with some white fir and incense-cedar. Many of the Jeffrey pines in the north end of the resort area and along the beach are old-growth monarchs that provide aesthetic values to the recreation area.

On the north side of the lodge, a Fomes annosus root disease center was identified (see map sent under separate cover) that had originated in a large pine stump. A white fir in the center is nearly dead and was probably under attack by the fir engraver in the upper bole. Two incense-cedars in the area of the disease center have symptoms indicative of root decay (thin, chlorotic crowns) and are probably infected. Their root systems were not excavated because of the location of the trees in the resort area. Symptoms indicate that they have 1 to 50% of their root systems decayed and at present have a low to moderate probability of failure.

Western dwarf mistletoe (Arceuthobium campylopodum) infects most of the Jeffrey pine in the resort area. Trees in the south end near Meeks Creek do not appear to be infected and the severity of infection increases from south to north. Many of the Jeffrey pines around the main lodge and cabin area and along the beach are heavily infected with large witches' brooms.

MANAGEMENT ALTERNATIVES

1. Continue Current Management Direction. Hazardous tree management will continue, but no other vegetation management will be initiated. Jeffrey pine mortality will likely increase in future years as stresses, including competition, compaction, dwarf mistletoe, and root diseases, continue to weaken trees. Accelerated Jeffrey pine beetle (Dendroctonus jeffreyi)-related mortality can be expected, particularly to pines heavily infected with dwarf mistletoe; some nearby, healthy Jeffrey pines may also be killed. The need for dead tree removal will increase.

Dwarf mistletoe will continue to intensify with more of the crown of trees becoming infected and additional witches' brooms developing or enlarging. The parasite will also slowly spread to uninfected trees, especially to the lower crowns of nearby dominants and codominants and throughout the crowns of intermediate and suppressed individuals.

The active annosus root disease center will slowly expand and conifers on the margin will decline and die or be windthrown. Jeffrey pines that become infected will likely succumb to the Jeffrey pine beetle. The two large incense-cedars with symptoms of root disease are not in imminent danger of toppling, but they should be observed to see when symptoms become worse, indicating a limited root system and the need for removal. New root disease centers may develop around conifer stumps that are caused by activities such as hazard tree removal.

2. Dwarf Mistletoe Management. The resort area should be considered as two separate areas, with different dwarf mistletoe management techniques for each area. The division between the two areas follows the entry road from Highway 89 toward the main lodge and continues on the south side of the lodge to the lake.

The intensity of infection north of this division requires substantial actions to promote the long-term health of the vegetation. There would be short-term effects on the recreational and aesthetic values of the area. Many of the large pines along the lake and around the cabins would have to be removed because they are infected throughout their crowns. Infected understory pines would also have to be removed. Some dominant and codominant pines could be pruned of witches' brooms to prolong their lives. The removal of trees would require revegetation of the area with resistant species. The management area would have to extend north of the resort area to ensure an adequate buffer to protect against reinfection.

The area south of the division is not as heavily infected and would require the removal of fewer trees for mistletoe control. The large leaning tree on the north side of the lodge would have to be removed, as would the group of heavily infected pines around the cabins to the east of the lodge. These trees are too heavily infected to be pruned free of infection and their removal is necessary to provide a complete buffer free of infected trees. The rest of the area would require the removal of selected trees to eliminate mistletoe infections and to improve spacing for the residuals. A thorough inspection and pruning of infected branches from these residuals would also be necessary. A retreatment of the area would be required in 2 to 3 years to eliminate missed and latent infections. Dwarf mistletoe suppression funding may be available for this work and the Basin is encouraged to contact FPM if it adopts this alternative. See the discussion in Alternative 2c, Nevada Beach, for more details.

3. Annosus Root Disease Management. Treat all freshly cut conifer stumps with borax (see p. 8, 3430 dated October 29, 1980).

Only two effective management techniques are available for existing root disease centers. One is to revegetate them with hardwoods. The other is to utilize the center as part of the recreation area by placing parking lots, grassy play areas, or structures over it. These must be large enough to cover the entire center to reduce the chance of hazardous tree situations in the future. Conifers around the margins with root disease symptoms (thin, chlorotic crowns with dead branches) could be removed to increase the size of opening and remove infected trees before they die.

4. Bark Beetle Management. See pp. 8-10 of 3430 memorandum dated October 29, 1980 for details. The risk to Jeffrey pines of successful bark beetle attacks will be reduced by implementing practices that reduce stresses on the trees, including controls for dwarf mistletoe, root disease, and competition.

5. Vegetation Management. The goal of this alternative is to promote tree health and vigor, thereby reducing and preventing unacceptable damage, and resulting in the maintenance of recreational values. Vegetation management will reduce the effects of pests and increase the longevity of individual trees by artificially practicing the natural process of selective tree removal. Thinning can remove diseased and weakened trees and increase the amount of soil moisture and nutrients available to residual trees. This will increase their vigor and permit them a longer life. In certain areas revegetation can be beneficial, especially when it provides a greater species mix and diversity to the stand. The regeneration should be resistant to existing pests, thereby reducing their impact and spread through the stand. See pp. 11-13 of the 3430 memorandum dated October 29, 1980 for details.

MEEKS BAY (CAMPGROUND)

The primary problem observed in the Forest Service-operated campground on the south side of Meeks Creek was the lodgepole pine mortality affecting virtually all the pines in about 15 campsites around the B5-B10 loops in the western section of the campground near Highway 89. This mortality was associated with two interacting factors, 1) spring to early summer flooding of the campsites and 2) the mountain pine beetle, D. ponderosae. The flood water completely covered the roots of the lodgepole pine, presumably causing a decrease in root activity (reduced oxygen and nutrient exchange), resulting in lowered host vigor and increased susceptibility to attack by the mountain pine beetle. Lodgepole pine mortality was not observed in other parts of the campground free of flooding. Bole cankers of stalactiform rust, Peridermium stalactiforme, were common on lodgepole pine, but most of these cankers died after the trees were killed by the mountain pine beetle.

No other pests or problem situations of significance were observed in the campground with the exception of some overstocked aggregations (for example, near the beach parking loop).

MANAGEMENT ALTERNATIVES

1. Vegetation Management. The primary problem is the flooding. On the assumption that a solution is found to prevent periodic flooding and that the affected campsites are to be rehabilitated, integrating pest considerations into plans for the re-establishment and subsequent management of the vegetation on the site should prevent and reduce future pest-related losses.

From the pest management standpoint, increasing species diversity would be beneficial. The specifics of what species to plant will depend upon local site conditions that exist after the flood management activities have been implemented. However, in general, a species mix including incense-cedar, Jeffrey pine and white fir, in addition to native hardwoods (alder, willow, aspen), would be appropriate. This should reduce the probability of a high proportion of the vegetative cover being killed over a short period of time by bark beetles. The use of shrubs

for screening and traffic management should also be considered. Lodgepole pine is risky to use (from the pest standpoint) for two reasons: 1) Even with flood control, the location of the campground relatively near the lake and Meeks Creek indicates that the water table may be subject to a certain amount of seasonal and yearly fluctuations. Observations in the Basin and in other areas in the Sierra Nevada indicate that lodgepole pines growing in areas subject to a fluctuating water table, such as near lakes or marshy habitats, are particularly susceptible to mountain pine beetle; and 2) there is a large area of unmanaged lodgepole pine extending up the Meeks Creek drainage immediately to the west of the campground area. The mountain pine beetle has been active throughout these stands and, while adult dispersal patterns are not clearly understood, immigration into the campground area is a distinct possibility. Even if it is shown that water table fluctuations are minimal in the campground after flood control activities are taken, lodgepole pine should probably be limited to 10% or less of the stand basal area.

2. Thinning. Consideration might be given to thinning overstocked Jeffrey pine aggregations to reduce the probabilities of future mortality. This would have the advantage of selecting the trees to be removed (as opposed to salvaging the trees the beetles kill) and the trees could be selected to favor a species mix that includes white fir and incense-cedar.

NEVADA BEACH CAMPGROUND

The overstory vegetation in this heavily-used developed recreation area (campground, day-use, and public beach) is primarily Jeffrey pine with a small number of white fir. Stocking in the campground is high with some scattered small openings. The number of trees in the day-use area is somewhat less, but stocking is still dense with crown closure of over 60% not unusual. The beach area is mostly lightly stocked with scattered individuals and small groups of trees.

The most significant pest in this recreation area is western dwarf mistletoe infecting Jeffrey pine. It is widespread throughout much of the area and infections are heavy in certain locations. Trees in bordering private landholdings are also infected. Other pests observed on Jeffrey pine included two rusts, limb rust (Peridermium filamentosum) and western gall rust (Peridermium harknessii), annosus root disease, Jeffrey pine beetle, flatheaded borer (Melanophila californica), and pine engraver beetle (Ips sp.). One annosus root disease center was identified at the south end of the beach area and involved an old pine stump and dead and ~~dying~~ pine regeneration.

This campground has been part of a long-term evaluation to determine the relationship between dwarf mistletoe infection and tree mortality. Since 1974, approximately 4% of the observed trees have died, most following the dry years of 1976 through 1979. Approximately two-thirds of the dead trees were severely infected (6-class dwarf mistletoe rating of 5 or 6). Over 90% of these had grown 10 mm or less radially during the 10 years preceding their death. The ultimate cause of death of

these trees was the Jeffrey pine beetle. This evaluation has been documented in a FPM report[1/] which is available from our office. Mortality of trees in this evaluation will continue to be monitored through the 1984 growing season.

MANAGEMENT ALTERNATIVES

1. Continue Current Management Direction. Mortality will continue throughout the campground and will be primarily associated with overstocking and severity of dwarf mistletoe infection. Mortality levels will increase when available soil moisture decreases during droughts. Dwarf mistletoe will intensify in crowns as the plant advances upward from lower infections. This intensification will increase tree stress and increase their susceptibility to successful bark beetle attacks. In addition to spread within trees, dwarf mistletoe infestations will expand to surrounding uninfected trees. The removal of any conifers will increase the possibility of the establishment of new annosus root disease centers. This includes the removal of recently killed trees. The existing root disease center will continue to expand and kill pines, but it will be somewhat limited by the low density and number of hosts. The Jeffrey pine beetle and associated insects will continue to kill trees of low vigor. Successful attacks on 1 or 2 trees may increase the likelihood of attacks to surrounding "healthy" Jeffrey pines.

2. Dwarf Mistletoe Management.

a. Beach area. Successful eradication of dwarf mistletoe in this area would require the removal of many of the Jeffrey pines that provide shade for the picnic tables. Removal of these trees would expose almost the entire beach. An alternative to removing these trees, many of which are classified as old-growth monarchs, would be to aid them by removing the large witches' brooms. These brooms act as nutrient sinks and are the largest robber of vigor from infected trees. Their removal would increase tree vigor, thereby increasing the probability of survival. The wide spacing of the trees, the road, and parking lots will function as effective barriers to limit spread of dwarf mistletoe into surrounding areas. Certain criteria exist to guide selection of trees for pruning witches' brooms. Do not prune pines that will have less than 30% live crown after pruning, and do not remove more than 50% of the crown. Trees with these characteristics should be removed.

1/ Vogler, D. R., and R. F. Scharpf. 1981. Dwarf mistletoe-related mortality of ponderosa and Jeffrey pines at five campgrounds in California and Nevada. FPM-R-5 Report No. 81-28.

The sandy soil, fluctuating water table, and high use limit the opportunities for regeneration. It must be realized, however, that even if witches' brooms are removed these trees will eventually die. By starting a regeneration program now, trees will be of sufficient size to be replacements as the older trees die. Only species resistant to the dwarf mistletoe, such as hardwoods, lodgepole pine, white fir, and incense-cedar, should be considered for regeneration.

b. Day-use area south of entrance road. The distribution and severity of infection throughout this area precludes a simple remedy. The only feasible long-term management strategy is for species conversion to resistant species. Because of the recreational values of the area, this can not be done quickly by removing all of the Jeffrey pines. However, a long-term program of gradual, selective tree removal, pruning of witches' brooms, and regenerating with resistant species could achieve the ultimate objective of eliminating all Jeffrey pines while retaining a satisfactory vegetative cover. Once this objective is accomplished, Jeffrey pine can be reintroduced into the area.

The first step would be to identify the most heavily infected trees whose removal would not seriously degrade the characteristics of the area and that would provide some openings for regeneration. To increase the longevity of residual trees, those that met the criteria mentioned in (a) above could be pruned of witches' brooms. In 5 to 10 years, after the regeneration is established, the second step would be to remove additional Jeffrey pines and plant more resistant species. This process of tree removal concurrent with regeneration would continue until all of the Jeffrey pines are removed. If Jeffrey pines are reintroduced, then care must be taken to satisfactorily buffer against any surrounding dwarf mistletoe infections.

c. Campground and day-use area north of entrance road. Dwarf mistletoe is throughout much, but not all, of this area and the severity is generally moderate. Either an aggressive or moderate management approach could be taken, with the greater long-term benefits accruing by implementing the former.

The objective of the moderate approach would be to maintain as many trees as possible on the site by minimizing the short-term effects of dwarf mistletoe. This would be accomplished by removing witches' brooms and possibly the removal of some heavily infected trees of poor vigor. The short-term costs of this program would be lower and the recreational use would be extended a few decades beyond what would be expected if there were no treatment, but the ultimate outcome would still be the loss of the majority of the Jeffrey pines and a campground denuded of trees.

The aggressive approach would have the greater long-term benefit, but at the higher short-term cost. The objective would be to maintain and enhance the recreational values and uses of the campground for the long-term. It would achieve the maximum benefit by being part of an overall vegetation management program that considers dwarf mistletoe as a significant problem, but not the sole problem, in the area.

A three-pronged strategy is required: tree removal, pruning witches' brooms, and regenerating with resistant species. Tree removal should eliminate heavily infected trees, trees of poor vigor, and trees that are competing in overstocked situations. Broom pruning would still be a short-term measure to prolong the life of selected trees until replacements are available. The regeneration, of course, would provide these replacements. It would also serve as a buffer strip around the boundaries of the campground where infected Jeffrey pines exist on adjoining private lands. In areas where the dwarf mistletoe infestation is light and infections are limited to the lower crowns, branch pruning could be done to remove the mistletoe and retain the tree. This procedure entails removing all of the branches up to the highest visible infection, and then removing two whorls of "uninfected" branches above this. Trees selected for this treatment should have at least the upper third of their crown free of infection and no more than one-half of their live crown should be removed.

Although the majority of the work can be done in one year, there is the need for retreatment to ensure effective control. The difficulty in seeing infections and the latent nature of infections for 2 or 3 years requires that stands, especially where branch pruning was a component, be reexamined and treated, if necessary, every 2 years for 6 years. The complexity and size of this campground and day-use area could result in different specific prescriptions for different areas. Therefore, it would be more manageable to divide the area into smaller management units that could be treated separately over a number of years. However, all units must be treated to assure attainment of the control objectives.

FPM has been able to supply funding for dwarf mistletoe control projects for the past several years, and it is anticipated that this will continue. The Basin is encouraged to apply for these funds for this and other campgrounds to improve the condition of the vegetation when other funds are not available. Four requirements must be fulfilled: a biological evaluation demonstrating the need and justification for the project; an environmental assessment, including an economic analysis, must be completed; a Project Proposal, Form FS 3400-2, must be submitted; and a post-treatment evaluation plan must be devised. This document serves as the biological evaluation and the FPM Staff is available to aid in the preparation of the other documents. It is recommended that the Basin request assistance of a pathologist during the selection of individual tree treatments if project funding is to be requested. This will ensure that there is agreement as to the proper technique and that dwarf mistletoe infections are effectively treated. The Basin is also encouraged to develop a multi-year schedule of activities as campgrounds are identified for dwarf mistletoe suppression. This will allow FPM to anticipate requests and plan for the Region's needs during program planning and budgeting activities.

Because of the use of the Nevada Beach campground as an evaluation area on the effects of dwarf mistletoe, an excellent opportunity exists to monitor the efficacy of treatment. Most of the trees in the study area

have been tagged and recorded and the effects of different treatments can be followed. Because of our desire to complete a 10-year evaluation, we would request that the Basin initiate treatments in areas outside of the study area and then enter the evaluation area following the 1984 completion.

3. Annosus Root Disease Management. See number 3, page 4 of this evaluation.

4. Vegetation Management. Although pest management techniques were described above separately, they will not be completely effective in reducing tree mortality and maintaining recreational values if implemented without considering vegetation health as the goal, rather than pest control. It is necessary to adopt some ecological processes and modify others to meet the goal of a healthy, natural-appearing forest. Such processes include maintaining diversity, providing regeneration, and limiting competition. This can be done by planning, including regeneration, tree removal, site use and occupancy, and pest management, where appropriate. It must be remembered that if we do not take actions to imitate natural processes, then these same processes will occur naturally without regard to goals and objectives.

APPENDIX

BIOLOGY OF PEST ORGANISMS

Reference should be made to the 1980 and 1983 reports for biological information on the majority of pests encountered.

Indian Paint Fungus (Echinodontium tinctorium). The primary hosts of this fungus in California are the true firs. Infection results in a brown stringy rot of the heartwood that may result in a hollow being formed. Conks of the fungus are very distinctive, being dark and woody with a rust red interior. The lower surface has hard, coarse teeth or spines while the upper surface is black and rough. When a tree bears two or more conks that are separated by more than 10 vertical feet, then extensive decay of the heartwood is present. Individual conks less than 6 inches across usually indicate that the decay has not reached the advanced stringy stage.

Infection occurs when spores germinate on stubs formed from the breaking of shade-killed branchlets less than 1 mm in diameter. These stubs are overgrown by new wood and the fungus remains quiescent for up to 50 years causing no decay. It is postulated that large branch stubs or large wounds may cause reactivation of the fungus, resulting in decay.